THE PLANTS OF SANTA BARBARA ISLAND CALIFORNIA

by
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THE PLANTS OF SANTA BARBARA ISLAND, CALIFORNIA[1]

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Santa Barbara Island is one of the smallest of the California off-shore islands. It has an area of only 2.6 square kilometers or one square statute mile. Located southwest of Los Angeles, it is 61 kilometers (38 miles) from the nearest point on the California mainland, and 39 kilometers (24 miles) from the nearest island, Santa Catalina (fig. 1). Contrary to several local maps, Santa Barbara Island is in Santa Barbara County (California Government Code, section 23142).

The island is roughly triangular in outline (figs. 2–3). Most of its shoreline is extremely precipitous. There are no sandy beaches, and the few narrow rocky beaches are mostly submerged at high tide. The major portion of the island is composed of gradually undulating slopes flanking a low north-south oriented ridge that connects Signal Peak and North Peak, two small rounded hills with elevations of 193 and 171 meters respectively. Both to the east and west of the ridge are broad sea-formed terraces that extend nearly to the shore. The lower part of the eastern slope is cut by several small gullies. A short distance off the southwest shore is the islet of Sutil, which rises abruptly to a narrow irregular ridge with a maximum elevation of 91 meters. Shag Rock, off the northerly shore, and an unnamed rock just west of Webster Point are both high enough out of the water to support a few plant species; however, neither of these latter two is known to have been botanically collected.

The soil of Santa Barbara Island is thin and coarse at the most windy locations, while on the terraces it is deep, fine, friable, and fertile. Extreme temperatures of 34.5° C (94° F) and 4° C (39° F) have been reported; but the average temperature varies only slightly throughout the year, and the overall climate is remarkably equitable (Dunkle, 1950, pp. 273, 348, 355). Both temperature and soil are strongly influenced by wind which averages more than 27 kilometers per hour (16.8 mph) at exposed sites and about 12.6 kilometers per hour (7.8 mph) at sheltered sites (Dunkle, 1950, pp. 273–274, 349). The prevailing wind is from the west-northwest.

An annual rainfall of roughly 30.5 cm (12 inches) is supplemented by high relative humidity (Dunkle, 1950, pp. 255, 274–275, 353, 355). Nearly all of the rain comes between October and April, but wet fogs

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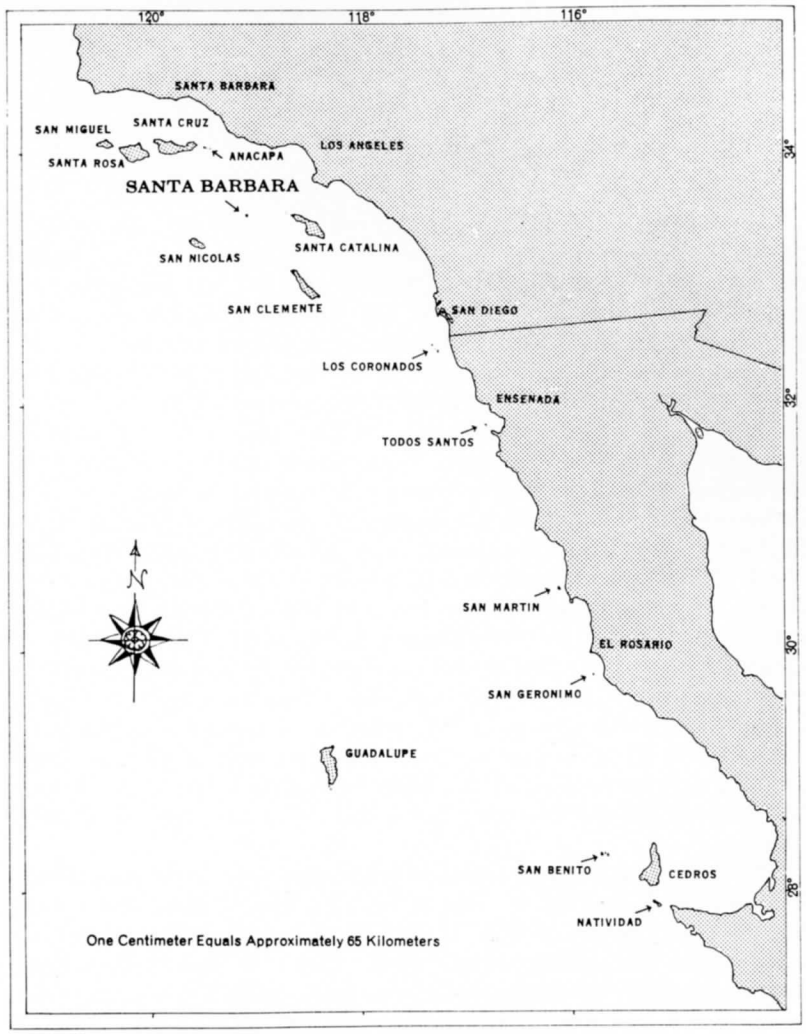

FIG. 1. California off-shore islands.

are frequent during the non-rainy months. Although very small temporary seeps have been reported at various times (Britton, 1897, p. 193; Dunkle, 1950, p. 270; Sumner, 1958, p. 3), there is no permanent fresh water on the island.

In the late winter and early spring most of Santa Barbara Island is covered with a luxuriant growth of suffrutescent and herbaceous plants. During the dry season the island looks bare and grayish brown. Grassland, iceplant, maritime-shrub, and sea-bluff plant communities are the most conspicuous components of the vegetation while woodland, chaparral, riparian, and beach communities are totally lacking. Introduced grasses and introduced iceplant occupy major portions of the slopes and terraces, thus suggesting the effects of man's activities on this island. At present most of the taxonomically important plants are relatively restricted. There are no trees on the island, and the shrubby vegetation is confined to scattered patches.

The native land animals include an insular endemic night-lizard that also occurs on San Nicolas and San Clemente islands, a small bat, and an endemic deer mouse found only on Santa Barbara Island (Savage, 1967; von Bloeker, 1967). California sea lions and a few northern elephant seals frequent the shore wherever it is low enough to provide them access (Bartholomew, 1967). Harbor seals are seen occasionally.

At least 70 different birds have been reported for Santa Barbara Island (Howell, 1917; Sumner & Bond, 1939; Grinnell & Miller, 1944; J. M. Diamond, personal communication, 1970). These include such interesting species and subspecies as the California brown pelican, Baird's pelagic cormorant, peregrine falcon, North American sparrow hawk, black oystercatcher, American pigeon guillemot, northern Xantus' murrelet, northern Cassin's auklet, North American barn owl, western burrowing owl, Costa's hummingbird, Allen's hummingbird, island horned lark, northern rock wren, dusky orange-crowned warbler, western meadowlark, San Clemente house finch, and the endemic Santa Barbara Island song sparrow. (Evaluations of available ornithological lists were provided by Alice I. Richardson and M. R. Benedict, personal communications, 1970).

Within the total of 70 birds reported, no more than 42 were listed in a single paper (Howell, 1917); and even this lower figure is a compilation based on observations over several years. Ten of the land bird species listed in 1917 were actually breeding on the island. By 1968 this number was reduced to six, not only the lowest figure for any of the islands from San Miguel to Los Coronados, but also the only one to show a net decline since 1917 (Diamond, 1969). In addition, the rate of turnover for breeding land bird species was higher than for any other of the above mentioned islands; and unfortunately the endemic song sparrow is now apparently extinct (J. M. Diamond, personal communication, 1970).

A preliminary study of the geology was made by Kemnitzer (1933). He described the island as being composed of two types of volcanic rock separated by a thin whitish foraminiferous zone. The present island was probably the north slope of a Miocene volcano (Emery, 1960, p. 66).

Valentine and Lipps (1967, pp. 30–31) suggested that Santa Barbara Island appeared sometime between 2 and 11 million years ago. They indicated that submarine ridges, possibly including islands near the present-day sites of San Clemente, Santa Catalina, and San Nicolas, were less than 15 kilometers from a similar submarine ridge including Santa Barbara Island, which in turn was connected to the northern

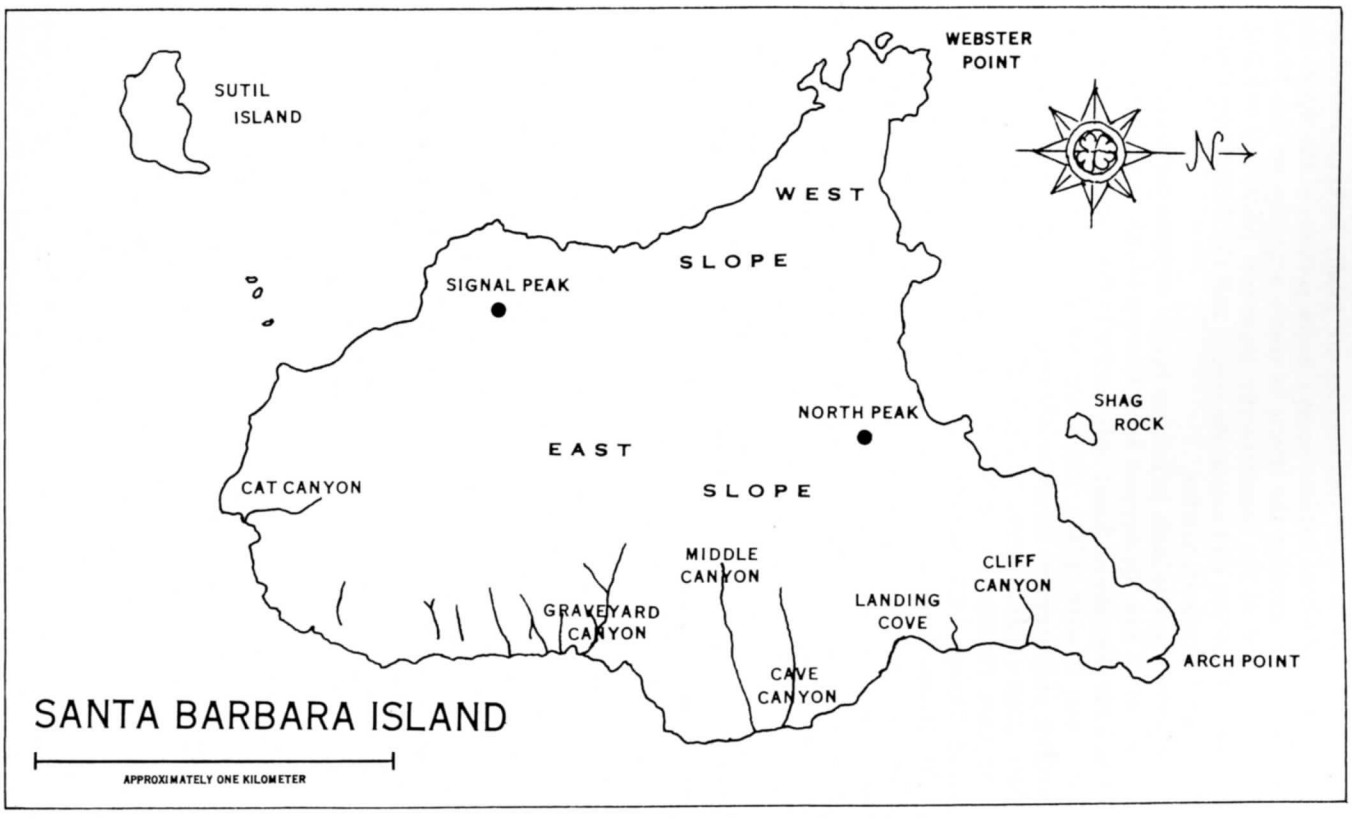

FIG. 2. Principal landmarks on Santa Barbara Island.

FIG. 3. Aerial photograph of Santa Barbara Island.

U.S. Department of Agriculture Photograph

islands. Corey (1954, p. 81), on the other hand, emphasized the possibility that Santa Barbara and Santa Catalina islands actually may have been connected during the Pliocene and that this combined land mass was quite close to San Clemente, San Nicolas, and the northern islands.

In any event, Santa Barbara Island was submerged during the late Pliocene or early Pleistocene (Valentine & Lipps, 1967, p. 30; J. H. Lipps, personal communication, 1970); thus the pertinent floristic history of this island probably begins only a few hundred thousand years ago. The terraces documented by Lipps, Valentine, and Mitchell (1968, pp. 292–294) indicate that subsequent repeated fluctuations of relative sea level restricted and expanded the size of the island during middle and late Pleistocene.

The Flora

In spite of its small size, isolation, uniform topography, and recent submergence, this island has a vascular flora of approximately 96 taxa in 75 genera. The best represented of the 32 families involved are Gramineae and Compositae with 18 species known for each. None of the genera are represented by a large number of species; the most for any one genus is five for *Bromus*. Many of the plants of Santa Barbara Island are widely distributed throughout much of California. On the other hand, *Lupinus, Rhus,* and *Haplopappus,* ubiquitous genera with wide-ranging species, are conspicuously absent from the island. The largest shrubby plants are *Eriogonum giganteum* var. *compactum,* three species of *Opuntia, Artemisia californica* var. *insularis, Baccharis pilularis* subsp. *consanguinea,* and *Coreopsis gigantea.*

The current knowledge of the plants of this island is based, in large part, on the herbarium specimens and other records of the following collectors:

James G. Cooper[1]—May 1863
William G. W. Harford and/or Albert Kellogg[2]—about 1871
Blanche Trask—May 1901, May 1902
Robert E. Snodgrass—August 1901
Henry Hemphill[1]—date uncertain
Barton W. Evermann—March 1918
LeRoy Abrams and Ira L. Wiggins—July 1931
Norman E. Bilderback—April 1938
Francis H. Elmore—August 1938
Richard M. Bond—April 1939, May 1940

[1] J. G. Cooper collected only a single known specimen, which is discussed in the plant list under *Galvezia*. The only known Hemphill specimen from Santa Barbara Island is of *Camissonia;* this was collected before September 1927, probably about 1901. G. P. Kanakoff collected only one specimen, a *Lotus*.

[2] According to Kellogg's description of *Coreopsis* (Proc. Calif. Acad. Sci. 4:198–199, 1873).

Meryl B. Dunkle—May 1939, March 1940, September 1941
George P. Kanakoff[1]—August 1940
Reid Moran—April-May 1941, February 1949
E. R. Blakley—October 1961, May 1963
Martin A. Piehl—May 1963
Ralph N. Philbrick—June 1964, March 1968, April 1969, February 1970
Ralph N. Philbrick and Michael R. Benedict—May 1966, March 1970
Ralph N. Philbrick, James K. McPherson, and Robert F. Thorne—April 1968
Ralph N. Philbrick and Donald W. Ricker—March 1969

The dates of these collections span the years from 1863 through the present; most of the earlier collections were made during the late 1930's and early 1940's at the time of the Channel Islands Biological Survey, organized by the Los Angeles County Museum. The extensive collections of M. B. Dunkle provide the major basis for comparison with today's flora of Santa Barbara Island.

Introduced Plants

Twenty-eight species, or approximately 29 percent of the Santa Barbara Island flora, are presumed to have been introduced to California during historic time (modified from Munz, 1959 & 1968); this includes a total of 10 grasses. Nearly all of these same introduced species are shared with each of the other California islands for which comparable data are available, i.e., 22 species shared with San Miguel, 23 with San Nicolas, 27 with Santa Catalina, and 25 with San Clemente.

The overall percentages of introduced plants for these four islands range from about 35 percent for San Nicolas (modified from Foreman, 1967) to about 22 percent for San Clemente (modified from Raven, 1963, and Thorne, 1969). In contrast the floras of other floristically related islands contain an even smaller proportion of introduced plants. Guadalupe has about 42 introduced taxa, which comprise 20 percent of its flora; and Cedros has about 22 introduced taxa, only 10 percent of its flora (Moran, 1967).

In addition to the 28 non-native plants that are considered to have been introduced to Santa Barbara Island, there are also a number that are native to the mainland and yet quite possibly should be treated as recently introduced to this island. For example, *Daucus pusillus* was not collected until 1963 and has never been found away from the Landing Cove area where supplies and people are usually put ashore.

Endemic Plants

Roughly 100 vascular plants are restricted to the California off-shore islands and have not been found on the mainland. Fourteen of these insular endemics are native to Santa Barbara Island and constitute the most notable feature of its flora. Three endemics, *Eriogonum giganteum* var. *compactum, Dudleya traskiae,* and *Platystemon californicus* var. *ciliatus,* are known only from this island (figs. 4–6).

Fig. 4. A low shrub of the endemic *Eriogonum giganteum* var. *compactum (B68–77)* flowering at the Santa Barbara Botanic Garden, September 1970.

Fig. 5. *Dudleya traskiae (Philbrick & Benedict B66–403),* taxonomically the most distinctive endemic of Santa Barbara Island. Shown here, 22 May 1966, on the southwest sea bluff between Cat Canyon and Signal Peak. Last seen in the wild in 1968.

The evolution of these endemics, whether on Santa Barbara Island or some similar land mass, is quite probably associated with Pleistocene fluctuations in land area—increase in number and diversity of available habitats as land area expanded and an intense selection during periods of restricted land area.

Floristic Relationships

One of the interesting questions to be asked about an island flora concerns the location of its nearest relatives. Such relationships provide a clue as to how the island was botanically populated. Sixty-eight plants presently reported from Santa Barbara Island are known to be part of the native flora of California (modified from Munz, 1959 & 1968) and are presumed to be native to this island. Some of these plants are shared

FIG. 6. Pressed specimens of *Platystemon californicus* var. *ciliatus (Dunkle 7400)*, endemic to Santa Barbara Island. Vigorous individuals frequently measure 25 cm across and produce 50 or more flowers at one time.

with San Miguel Island (unpublished data at the Santa Barbara Botanic Garden), San Nicolas Island (Foreman, 1967; unpublished data at the Santa Barbara Botanic Garden), Santa Catalina Island (modified from Thorne, 1967 & 1969), San Clemente Island (modified from Raven, 1963, and Thorne, 1969), and Guadalupe Island (Reid Moran, personal communication, 1969). The native plants of the other California islands are not considered in this particular connection because comprehensive data are still being accumulated. Eventually the relationships between the native floras of all these islands should be investigated.

On the basis of the known number of shared native vascular plants (fig. 7), Santa Barbara Island shows its closest relationship to San Clemente Island (61 taxa shared) and Santa Catalina Island (57 taxa shared). The floristically related Guadalupe Island shares 38 taxa with Santa Barbara Island in spite of the two being separated by several hundred kilometers. San Miguel and San Nicolas both share 34 taxa with Santa Barbara.

A similar pattern of relationship is shown by examining the insular endemic plants that Santa Barbara Island shares with other islands (fig. 8, table 1). San Clemente and Santa Barbara share 10 of these taxa; Santa Catalina and Santa Barbara, eight; San Nicolas and Santa Barbara, six. The distant Guadalupe Island shares five with Santa Barbara Island. Anacapa, the nearest of the northern islands, shares four. Santa Cruz, the second nearest northern island, shares three. Santa Rosa, farther up the coast, and Los Coronados, to the south, each share two with Santa Barbara. All other of the California islands, as far south

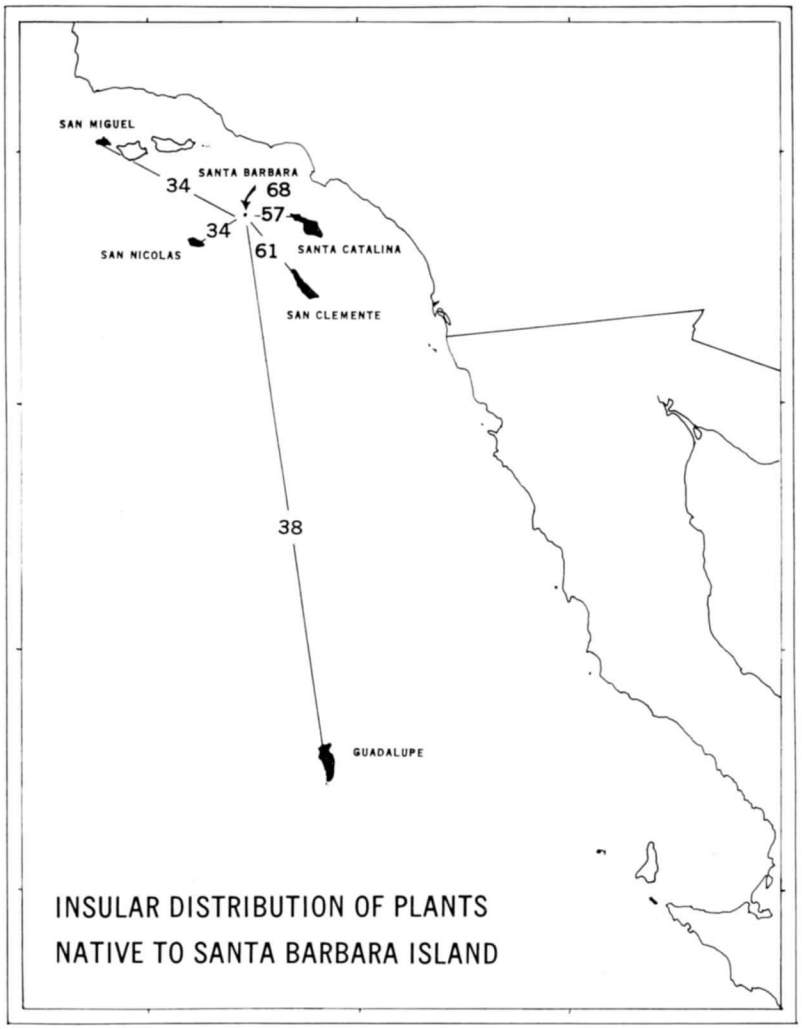

FIG. 7. All but 7 of the 68 native vascular plants known from Santa Barbara Island are a part of the relatively large flora of San Clemente Island. Santa Barbara Island also shares many plants with Santa Catalina Island. Present data indicate that the floristic affinities of Santa Barbara Island are with the southern islands. The numbers shared with islands not labeled on this map have yet to be determined.

as Natividad, share no more than a single insular endemic with Santa Barbara Island. Not one insular endemic is shared exclusively by Santa Barbara Island and any of the northern islands.

The *Phacelia* of Santa Barbara Island is of particular interest; it combines characteristics of the relatively widespread *P. distans* and the insular endemic *P. floribunda*. The former occurs on San Miguel and

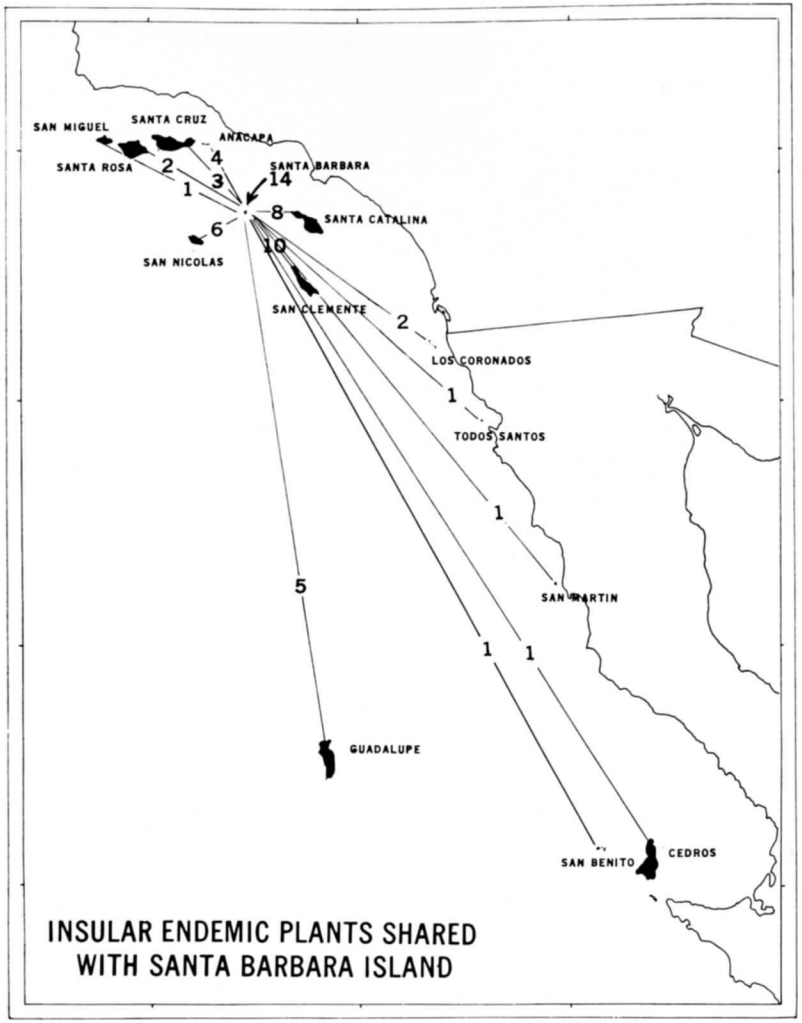

FIG. 8. Many vascular plants occur only on the California off-shore islands. Fourteen of these endemics are native to Santa Barbara Island. Ten of the 14 also occur on San Clemente Island thus indicating a close floristic relationship between these two islands. See also table 1.

Santa Catalina; *P. floribunda* occurs on Guadalupe; and both species occur on San Clemente. Although the Santa Barbara Island *Phacelia* apparently is restricted to the one island, it is not considered here as a stabilized endemic and is not included in the floristic tabulations of this paper. In addition to this *Phacelia,* the only native plants not shared with San Clemente Island are *Hutchinsia procumbens, Astragalus trask-*

TABLE 1. KNOWN DISTRIBUTIONS OF INSULAR ENDEMIC PLANTS OCCURRING ON SANTA BARBARA ISLAND

Eriogonum giganteum compactum	—	—	—	—	SBa	—	—	—	—	—	—	—	—	—	—
Eschscholzia ramosa	—	SR	SCr	—	SBa	—	SCa	SCl	LC	TS	—	—	G	SBe	C
Platystemon californicus ciliatus	—	—	—	—	SBa	—	—	—	—	—	—	—	—	—	—
Dudleya traskiae	—	—	—	—	SBa	—	—	—	—	—	—	—	—	—	—
Astragalus traskiae	—	—	—	—	SBa	SN	—	—	—	—	—	—	—	—	—
Lotus argophyllus ornithopus	—	—	—	—	SBa	SN	SCa	SCl	—	—	—	—	G	—	—
Trifolium palmeri	—	—	—	—	SBa	SN	SCa	SCl	—	—	—	—	G	—	—
Calystegia macrostegia macrostegia	SM	SR	SCr	A	SBa	SN	SCa	SCl	—	—	SMa	G		—	—
Gilia nevinii	—	—	SCr	A	SBa	—	SCa	SCl	—	—	—	G		—	—
Galvezia speciosa	—	—	—	—	SBa	—	SCa	SCl	—	—	—	—		—	—
Artemisia californica insularis	—	—	—	—	SBa	SN	—	SCl	—	—	—	—		—	—
Eriophyllum nevinii	—	—	—	—	SBa	—	SCa	SCl	—	—	—	—		—	—
Hemizonia clementina	—	—	—	A	SBa	SN	SCa	SCl	—	—	—	—		—	—
Malacothrix foliosa	—	—	—	A	SBa	—	—	SCl	LC	—	—	—		—	—
Totals	1	2	3	4	14	6	8	10	2	1	1	5		1	1

Fourteen insular endemic plants are native to Santa Barbara Island. An *Eriogonum, Platystemon,* and *Dudleya* occur nowhere else. An *Eschscholzia* and a *Calystegia* are relatively widespread; each is known from at least 10 islands. The remaining endemics are particularly indicative of a close floristic relationship among the southern islands.

Abbreviations refer to San Miguel, Santa Rosa, Santa Cruz, Anacapa, Santa Barbara, San Nicolas, Santa Catalina, San Clemente, Los Corcnados, Todos Santos, San Martin, Guadalupe, San Benito, and Cedros islands. This tabulation is the basis of the map shown in figure 8.

iae, Coreopsis gigantea, and the three endemic taxa restricted to Santa Barbara Island.

The overall floristic relationship among most of the southern islands is indicative of relatively close proximity, similar climatic conditions, and colonization from similar plant sources by means of bird migrations, wind patterns, ocean currents, and human visitation.

Present-day Vegetational Changes

Most of the dispersal of the plants making up this flora has taken place over many thousands of years; however, changes are still going on. To date five species have been eliminated from the flora of Santa Barbara Island. These are two maritime plants that were collected only once, *Camissonia cheiranthifolia* subsp. *cheiranthifolia* and *Galvezia speciosa,* and three marginally adapted introduced weeds, *Bromus diandrus, Brassica nigra,* and *Xanthium spinosum.* It now seems probable that the Santa Barbara Island endemic *Dudleya traskiae* has also been eliminated.

During the past 30 or so years, 20 species have been added to this flora. *Phyllospadix scouleri, Vulpia octoflora, Hesperocnide tenella, Opuntia littoralis* sensu stricto, and *Amsinckia spectabilis* are presumed to be native but are either inconspicuous or taxonomically difficult and probably were overlooked by previous botanists. Ten others were introduced to California or are more or less weedy California natives, which are not surprising additions to disturbed areas; these are *Avena barbata, Bromus mollis, Hordeum pusillum, Parapholis incurva, Cannabis sativa, Thelypodium lasiophyllum* var. *lasiophyllum, Daucus pusillus, Centaurea melitensis, Silybum marianum,* and *Sonchus tenerrimus.* The remaining five, *Calandrinia ciliata* var. *menziesii, Hutchinsia procumbens, Pholistoma auritum* var. *auritum, Microseris linearifolia,* and *Rafinesquia californica,* are perhaps the most significant of the recent arrivals.

During the same 30 years, changes in distribution and frequency have been more conspicuous than additions and deletions. The populations of *Coreopsis gigantea,* which already had been nearly eliminated from the upper terraces by farming prior to Dunkle's study, now have been reduced to isolated colonies (figs. 9–12b), primarily by the burrowing and gnawing of introduced rabbits. The drastic reduction of this plant may be responsible for the apparent extinction of the Santa Barbara Island song sparrow, which was abundant prior to 1940 and was intimately associated with the *Coreopsis* thickets (Townsend, 1890, p. 139; Sumner & Bond, 1939, pp. 9–10; Dunkle, 1950, p. 280; Sumner, 1958, p. 3). Elsewhere this succulent-stemmed arborescent shrub with easily breakable branches has persisted only in scattered locations on the Southern California coast and the off-shore islands.

Greatly increased, on the other hand, is the area covered by the South African iceplant, *Mesembryanthemum crystallinum.* Dunkle (1950, p. 359) mapped this species as occupying major areas on the two peaks of the island and as coexisting with *Suaeda californica* in several sea gull nesting areas. Since that time, the iceplant has carpeted a much larger portion of the island, excluding other vegetation by physical or physiological means. When wind or other disturbance opens up small areas within this carpet, the soil often remains bare or is invaded only

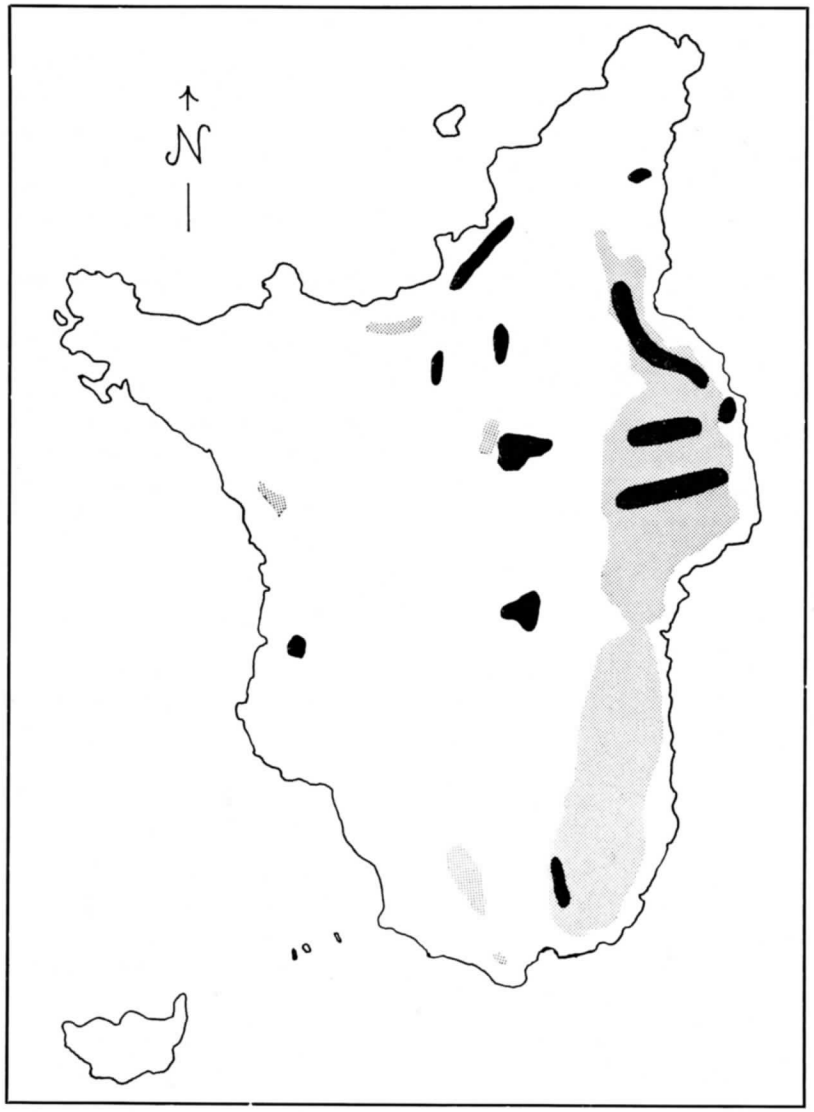

Fig. 9. Changes in the distribution of *Coreopsis gigantea* on Santa Barbara Island. Distribution for 1939–1941 is mapped in gray (from Dunkle, 1950, p. 359). Distribution for 1969–1970 is mapped in black. The reduction in the area occupied by this species is primarily the result of gnawing and tunneling by introduced rabbits.

by weedy introduced plants, such as *Malva parviflora* and *Erodium cicutarium*.

The major patches of *Suaeda californica*, particularly those on the West Slope, have been greatly reduced in area and density since 1968. Previous associations of *Suaeda* and *Mesembryanthemum* in gull nesting sites are now dominated by *M. crystallinum* with only a few scattered plants of *Suaeda*. From this pattern it is suggested that the gull may be important in the introduction of this iceplant and that, once established, the iceplant may contribute to the decline of the *Suaeda*. The introduced rabbits, which previously burrowed in the dense *Suaeda* patches, undoubtedly have contributed to this decline.

A third important change involves the restricted endemic *Dudleya traskiae*. By 1961 there were already in evidence many dead plants of this species (E. R. Blakley, personal communication, 1969). In 1968 only a few healthy *Dudleya* plants could be found on the island. In 1970 no live rosettes were found in any of the four locations where this plant had been previously collected. Again the major destruction is apparently due to gnawing by rabbits.

Man's Effect on the Vegetation

There are only fragmentary indications of early human activities on Santa Barbara Island. A few conspicuous shell mounds give evidence of former Indian visitation. The first suggestion of danger to the vegetation is based on an implication by T. J. Farnham that goats were placed on the island prior to 1846. He wrote: "Farther off shore and southward, are the islands of Santa Barbara, San Nicolas and San Clemente. . . . They are densely populated with goats" (Farnham, 1849, p. 107).

Feral house cats were extremely abundant shortly before 1896 (H. Bay Webster interview with Don Meadows, 1940). By 1908 these persistent wild cats were again numerous enough to be blamed for the drastic reduction in the nesting populations of Xantus' murrelet and the once abundant Cassin's auklet (Howell, 1917, pp. 20–22).

Britton (1897, pp. 192, 194) noted "ice-plant", "a field of malva weed", a lobsterman's "hut of lath and canvas", and "scattered . . . skulls and hoofs of sheep put on the island as a business venture some years ago". Additional introduced weeds, such as *Chenopodium murale*, were first collected in 1901 by R. E. Snodgrass.

About 1915 a group headed by the Alvin Hyder family moved to the island[1]. At times this group numbered as many as 17 people. A total of 11 structures were built, and a series of catch basins and reservoirs were set up to store rainwater and water hauled from the mainland. They brought with them two mules and two horses for plowing and other farm chores. For the first three years they concentrated on raising barley

[1] The history of the Hyder activities on Santa Barbara Island is reported on the basis of a 1970 interview with Denton O. Hyder, the only son of Alvin Hyder.

Fig. 10a. Vegetation of East Slope, Santa Barbara Island, as photographed by Lowell Sumner on 15 April 1939. The foreground is dominated by introduced *Hordeum glaucum* and native *Coreopsis gigantea*. His original notation: "the broad mesa of Santa Barbara Island where exotic weeds . . . struggle with native species".

Fig. 10b. Same location as in figure 10a on 21 March 1970. In the foreground are scattered rosettes of *Mesembryanthemum crystallinum* on a carpet of dried plants of this same introduced species, the patch of *Coreopsis* obviously lost the "struggle".

FIG. 11a. A dense stand of *Coreopsis gigantea* in lower Cave Canyon, Santa Barbara Island. Photograph by Lowell Sumner, 14 April 1939.

Fig. 11b. Same location as in figure 11a on 21 March 1970. Note complete disappearance of *Coreopsis* from the south-facing slope in the foreground and the conspicuous thinning of the stand on the opposite slope.

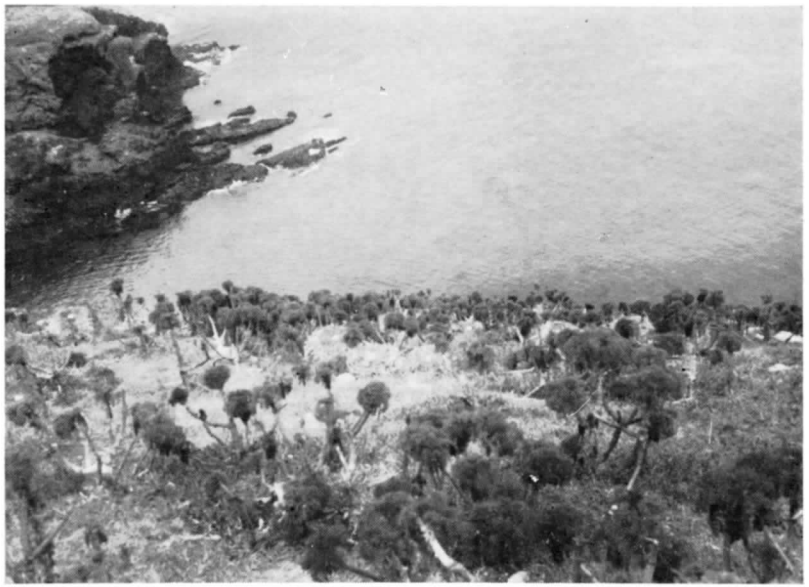

FIG. 12a. A slope with short but healthy *Coreopsis gigantea* plants on Santa Barbara Island just west of North Peak summit. Photograph by Don Meadows, 19 March 1940.

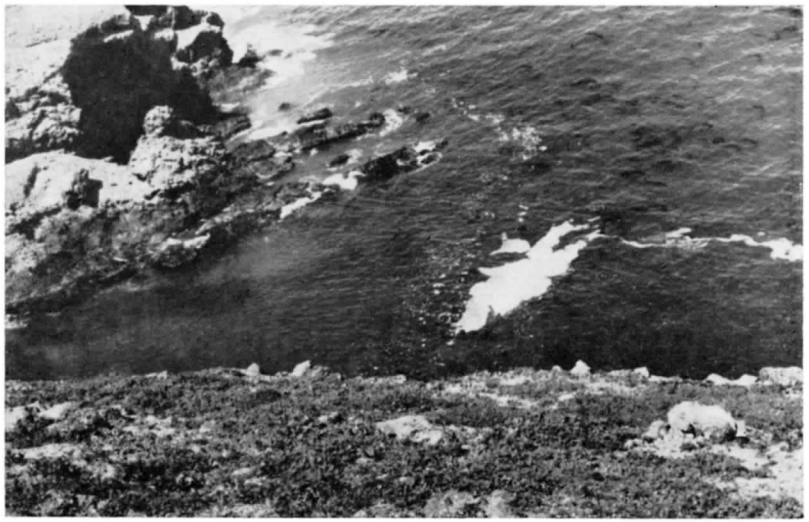

FIG. 12b. Thirty years later, 21 March 1970, at the same location as in figure 12a. Introduced *Mesembryanthemum crystallinum* has replaced the native *Coreopsis* on this west-facing slope.

hay in a large field on the East Slope just east of Signal Peak. Sheep became the primary agricultural concern during the remaining seven years of the lease. A maximum of about "200 sheep" were kept on the island at one time. The Hyders also brought approximately "2,000 Belgian hares" [*Oryctolagus*] from various sources in the Santa Ana area. Although it is estimated that the number of these rabbits might have "doubled" temporarily, this venture soon was considered a failure; and the blame was again placed on the cats. Various other animals were raised; these included geese, ducks, chickens, turkeys, pigs, and up to "25 goats". Gull eggs were systematically harvested; only one egg was taken from each nest.

Farming necessitated clearing of both the *Coreopsis* and *Mesembryanthemum*. The former was pulled up by hand; and the latter was cut, allowed to dry, and burned. These fires took place each year between about 1917 and 1921. They resulted in the burning over of nearly all the tillable portion of the island. Several acres of corn and potatoes were raised near the southern edge of the upper West Slope.

Occasional sacks of grain and a few bales of hay were brought to the island. All major landings of materials, animals, and people were confined to the Landing Cove. The conspicuous agricultural weeds of this time were "oats, mustard, foxtail, and filaree". A "castor-bean" shrub, *Ricinus,* persisted at the Landing Cove for a short time. Of all the animals that were introduced by the Hyders only the rabbit persisted, and this probably not beyond the 1940's when a different rabbit was introduced. By 1926 the Hyder group had moved off Santa Barbara Island, but during that year D. O. Hyder returned for two months to graze sheep from his family's H-A Ranch in the Cuyama Valley of northern Santa Barbara County.

In 1931 *Mesembryanthemum* was the major vegetation over most of the island; but the *Coreopsis* was in good condition, especially at the top of the cliffs on the east side of the island (I. L. Wiggins, personal communication, 1970). At that time additional introduced weeds (*Atriplex semibaccata, Medicago polymorpha* var. *polymorpha, Sonchus oleraceus,* and *Xanthium spinosum*) were documented by the collections of LeRoy Abrams and I. L. Wiggins.

By 1939 several two- to three-meter *Eucalyptus* trees had grown for a time near the Landing Cove (Sumner & Bond, 1939, p. 15). Sumner & Bond (1939, p. 10) noted droppings of "former temporarily resident dogs". Cats were comparatively common, but only three rabbits were seen on the island (Sumner, 1958, p. 7; Reddick, 1939, p. 2). "Coreopsis in the unfarmed areas was at that time much more luxuriant than later" (Sumner, 1958, p. 4). During the spring of 1941 Mr. and Mrs. Clarence Fry spent one month on the island; they saw a total of 13 cats and two rabbits (Sumner, 1958, p. 7).

From 1942 through 1946 the island served as an aircraft early warning outpost and subsequently as a photographic tracking station; motor

vehicles were in use and an increase in dirt roadways resulted (G. H. Bowen, personal communication, 1968). Barracks, miscellaneous buildings, and additional boat loading facilities were constructed; even a few sheep were again placed temporarily on the island (Sumner, 1958, p. 7). At this time "New Zealand Red" rabbits were introduced (Sumner, 1958, p. 7). However, several years passed before these rabbits, *Oryctolagus,* caused any noticeable destruction of the vegetation.

In 1949 the island continued to support vigorous thickets of *Coreopsis* at about the same time as the road system was expanded to the Webster Point area and the currently-existing timber landing platform and cable car track were constructed (Reid Moran photographs, February 1949). *Coreopsis* to "a height of 8 or 10 feet" were noted at Landing Cove; "the whole east side of the island, up to an elevation of about 400 feet" was "covered with a dense forest" of these plants (P. C. Orr field notes, 9–11 February 1949). The following year, in 1950, only one cat and two rabbits were observed as Lowell Sumner began several years of observation on the interaction of Santa Barbara Island plants and animals. He reported that

> . . . the ecological effects of this new rabbit introduction were as yet scarcely evident. Two sub-adult rabbits were seen but the native "jungle" had reached such a peak of recovery that rabbit trails were almost invisible. . . . Large areas of Coreopsis which had been waist high in 1939 were head high in 1950. A younger generation was recapturing the old hayfield. . . . Extensive cactus patches . . . had been overwhelmed . . . by the spreading Coreopsis, morning glory, . . . and box thorn . . . (Sumner, 1958, p. 8).

Sumner's observations (1958, p. 4) indicate that 1952 was the approximate date of the rapid and destructive increase in the second rabbit population. The resulting decrease in *Coreopsis* and *Calystegia* and the related increase in *Mesembryanthemum* are shown in figure 13.

In 1953 the rabbits were conspicuously abundant, and the vegetation had seriously declined.

> Rabbits, all of the New Zealand Red strain, ran about in great numbers. The Coreopsis "jungle" had a stricken aspect. Many of the trees had been girdled and felled by the rabbits. . . . Throughout the thinning stands of survivors, bare ground showed everywhere through a shriveled carpet of dying vegetation. . . . This was because nearly all of the "forest" understory of low annuals, and of perennials such as the trailing morning glory, had been killed by the rabbits (Sumner, 1958, pp. 8–9).

There had been previous unofficial rabbit shooting on the island, and in October 1954 a rabbit control program was begun by the National Park Service and the U.S. Fish and Wildlife Service. At that time the

vegetation, even on nearly inaccessible cliffs, was spectacularly reduced by the gnawing of an estimated 712 rabbits.

> Living vegetation was so sparse that rabbit shooters could walk almost anywhere through the withering jungle. The rabbit population now so far exceeded the available burrows and concealing thickets that scores of the animals crouched in plain sight on the bare ground, taking advantage of any slight shade afforded by the surviving Coreopsis. Acres of box thorn [and] island sagebrush . . . had been exterminated. The giant morning glory was reduced to a few leafless, prostrate runners except where an occasional plant had been able to put out a few leaves beyond reach of the rabbits by climbing to the top of a still-standing Coreopsis (Sumner, 1958, p. 10).

In 1955 the estimated rabbit population reached 2,621; and the iceplant, *Mesembryanthemum crystallinum,* was rapidly increasing (fig. 13). That same year the rabbit control program was expanded to include strychnine poisoning.

> Iceplant . . . had staged a conspicuous, large-scale invasion of previously denunded ground and extended even beneath the Coreopsis, where it replaced the native wildflowers of earlier years (Sumner, 1958, p. 12).

Although the 1956 rabbit estimate was down to 727, this was still far too many; and the native vegetation declined even further while the introduced iceplant continued to spread.

> Coreopsis had been reduced by 25 to 30 percent through beavering, girdling and undermining. Wild cucumber, formerly common but not a preferred rabbit food, was reduced to an occasional small green runner. Morning glory, the best indicator of rabbit pressure, was so far gone that in three days the writer found only one plant that showed slight signs of current life. Small wild flowers seemed almost non-existent, and even the hardy Mediterranean grasses were greatly reduced. . . . Iceplant continued to spread enormously, forming dense carpets on most of the open ground outside of the Coreopsis patches. By now it had replaced most of the native plants and had even to a large extent replaced the dense wild oat stands in the former hayfield (Sumner, 1958, pp. 13–14).

The last known evidence of cats on Santa Barbara Island (Sumner, 1958, p. 17) is for the year 1957. During that year a continuation of the annual shooting and poisoning reduced the rabbit population to an estimated 560. Still the number was too high, and the vegetation continued to decline.

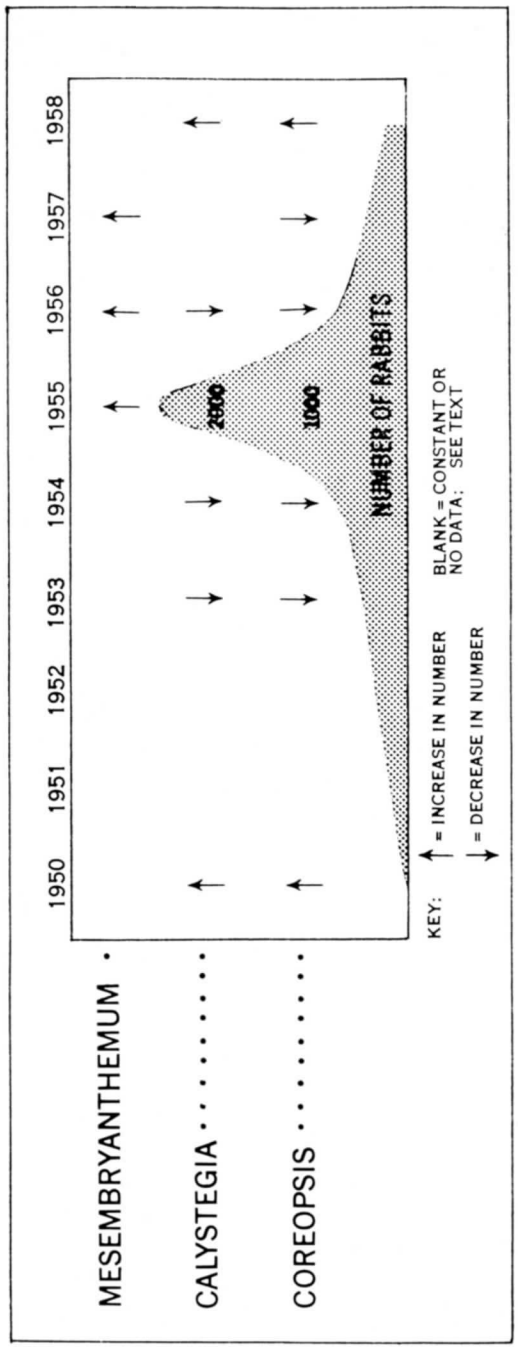

FIG. 13. Increase and decrease of three selected plants in relation to changes in the number of introduced rabbits on Santa Barbara Island. The rabbit population increased between 1950 and 1955. These animals drastically reduced the native populations of *Coreopsis gigantea* and *Calystegia macrostegia* thus allowing the area occupied by the relatively rabbit-resistant *Mesembryanthemum crystallinum* to increase spectacularly from 1955 through 1957. Rabbit poisoning was begun in 1955; this, in addition to increased rainfall, allowed the native vegetation to begin a modest recovery in 1958. (Data from Sumner, 1958, pp. 8–21.)

> The vegetation . . . had suffered a decline even more pronounced than that of the rabbits. Approximately 50 percent of the Coreopsis was dead and prostrate. The bulk of the morning glories had been able to keep no leaves or runners, and appeared nearly dead. . . . Acres of box thorn appeared to be nearly dead. Even the brome grasses and wild oats were sparse; cheat grass was now the dominant surviving grass but had attained an average height of only 6 inches. . . . Iceplant had continued to make enormous gains, occupying nearly all ground laid bare by the rabbits. More than half the surface of the island now appeared covered by it . . . (Sumner, 1958, pp. 15–16).

In 1958 Sumner noted that the "song sparrows were still holding their own" (Sumner, 1958, p. 19); this is the last known field report of this endemic bird. Yet heavy rainfall and a further reduction in the number of rabbits combined to allow the vegetation to begin to recover (fig. 13).

> Surviving Coreopsis were putting on a blazing show of golden yellow. . . . The first new young plants of this species since the rabbit outbreak were now observed. The number of such young plants was considerably less than ½ of 1 percent of the total stand, and some of them had been partly eaten by rabbits. . . . Morning glory had revived appreciably, even in areas where most of the plants had, during the previous two years, appeared virtually lifeless. . . . Box thorn showed the first extensive development of new leaves in years, though approximately 35 percent of the original stand was dead. Island sagebrush exhibited strong recovery. Wild cucumber had revived. Annual wildflowers seen rarely or not at all since 1950 were common to profuse. . . . Wild oats [were] . . . waist and shoulder high. . . . The foxtail and brome grasses experienced a comparable resurgence. . . . Iceplant had attained astounding luxuriance and density, forming on 50 percent or more of the island a tough, slippery, wet barrier twelve to eighteen inches deep (!) very difficult for human beings to wade through and impenetrable to the rabbits (Sumner, 1958, pp. 17–18).

Then in the summer of 1959 an accidental fire covered most of the island. "It burned nearly all the vegetation from water's edge on the east shore of the island to the crest of the ridge where it was halted by the strong winds from the west slope. . . . Two-thirds of the island was denuded right down to mineral soil. . . . There were perhaps 30 rabbits left on the vegetated west slope; the others either were killed outright or could find nothing to eat" (Lowell Sumner, personal communication, 1970).

The Park Service has continued efforts to control the introduced rabbits. However, as even selective poisoning increases the risk to the native animals of the island, the main emphasis is now on shooting. To date, the rabbits have not been exterminated, and destruction of the vegetation continues.

Fishermen have stopped at the island for many years, and the Coast Guard has operated a lighthouse near the northeast corner of the island since 1929 (U.S. Coast Guard, Light list 3:32, 1969). Established as a National Monument in 1938, the island now has several hundred visitors each year. To the untrained eye there are only a few clues to the history of man's activities on Santa Barbara Island, but it is quite certain that the island would look very different today if domestic animals had never been introduced there.

Summary and Conclusion

The small flora of Santa Barbara Island, although sharing elements with other portions of California (especially with San Clemente Island), is of interest because of the accumulation of several unique plants during a period of less than a million years. These endemic plants are varieties of *Eriogonum* and *Platystemon* and a species of *Dudleya*.

In the last few decades native species of *Suaeda, Dudleya, Coreopsis,* and other genera have been drastically reduced on this island. In large part, they have been replaced by expansion of an introduced *Mesembryanthemum*.

Hopefully this paper will do more than serve as a demonstration of the influence of man, weeds, and introduced animals. Perhaps it will help urge preservation of the native plants and animals of Santa Barbara Island so that they remain available for further study, particularly from an evolutionary and ecological point of view.

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